

Physiology of the Female Reproductive System (3)

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ILOs

By the end of this lecture the student should be able to:

- Explain the roles of the pituitary and the hypothalamus in the regulation of ovarian function, and the role of feedback loops in this process.
- Explain the effect of lactation on menstrual cycle
- Apply knowledge to solve MCQs and clinical problems

Control of ovarian function

- Follicle-stimulating hormone (FSH) from the anterior pituitary is responsible for the early maturation of the ovarian follicles.
- FSH and luteinizing hormone (LH) together are responsible for their final maturation.
- A burst of LH secretion is responsible for ovulation and the initial formation of the corpus luteum.
- A smaller midcycle burst of FSH secretion also occurs, the significance of which is uncertain.
- LH stimulates the secretion of estrogen and progesterone from the corpus luteum.

The control of ovarian function occurs at 3 levels:

Hypothalamic level

- Hypothalamic control is exerted by gonadotropin-releasing hormone (GnRH) which stimulates the secretion of FSH and LH.
- GnRH is normally secreted in episodic bursts.
- The intermittent, pulsatile secretion of GnRH by the hypothalamus stimulates pulsatile release of LH from the anterior pituitary gland.

- Also, fluctuations in the frequency and amplitude of the GnRH bursts are important in generating the hormonal changes that are responsible for the menstrual cycle.

Anterior pituitary level

- Secretion of FSH and LH.
- FSH and LH are regulated by the pulsatile secretion of hypothalamic GnRH and by the feedback action of the ovarian hormones.

Ovarian level

- Secretion of estrogen, progesterone and inhibin
- The ovarian function is directly controlled by the anterior pituitary gonadotropic hormones (FSH and LH)

Control of ovarian cycle

- The ovarian cycle is regulated by complex hormonal interactions
- The ovary has two related endocrine units:
 - The growing follicle: secretes estrogen during the first half of the cycle
 - The corpus luteum: secretes both progesterone and estrogen, during the last half of the cycle.
- These units are sequentially triggered by complex cyclic hormonal relationships among the hypothalamus, anterior pituitary, and these two ovarian endocrine units.

Control of follicular phase

- During the early part of the follicular phase, inhibin B is low, FSH is moderately elevated and LH secretion increases slightly, helping follicular growth.
- Both LH and FSH are required for synthesis and secretion of estrogen by the follicle.
- The rising, moderate levels of estrogen characterizing the follicular phase inhibits GnRH, FSH and LH in a negative feedback manner by:
 - acting directly on the hypothalamus to inhibit GnRH secretion, thus suppressing release of FSH and LH from the anterior pituitary.
 - acting directly on the anterior pituitary to inhibit FSH and LH but FSH is more inhibited.

- Another factor to the fall in FSH during the follicular phase is secretion of inhibin by the follicular granulose cells.
- Inhibin inhibits FSH secretion by acting at the anterior pituitary.
- The decline in FSH secretion causes atresia of all growing follicles except the most mature follicle.

N.B.

Both granulosa and thecal cells participate in estrogen production.

- Theca cells in the ovarian follicle stimulate androgen production under the effect of LH.
- Granulosa cells promote conversion of thecal androgens into estrogens under the effect of FSH.

Control of Ovulation

- LH is necessary for final follicular growth and ovulation.
- At 36–48 h before ovulation (at about the 14th day of the cycle), the estrogen feedback effect becomes positive, and this initiates the burst of LH secretion (sudden marked increase in LH secretion) (LH surge) that produces ovulation and the subsequent luteinization of the ruptured follicle.
- Ovulation occurs about 9 h after the LH peak.
- During late part of follicular phase:
 - Mature graafian follicle secretes large quantities of estrogen reaching its peak.
 - The high plasma level of estrogen exerts a positive feedback effect and stimulates massive increase in LH secretion by:
 - acting directly on the hypothalamus to increase GnRH secretion, thus increase release of both FSH and LH from the anterior pituitary.
 - acting directly on the anterior pituitary to increase LH.

N.B.

- The midcycle LH surge terminates the follicular phase and initiates the luteal phase.
- Midcycle FSH surge occurs also, but its function is not known.

Effects of LH surge

- It stops estrogen synthesis by ruptured follicle.
- It causes completion of arrested first meiotic division and conversion of primary oocyte to secondary oocyte.
- It triggers ovulation by production of local prostaglandins and digesting enzymes resulting in rupture of follicle and release of ovum.
- It causes differentiation of follicular cells into luteal cells and formation of corpus luteum.

Control of luteal phase

- The rise in LH causes the development and maintenance of corpus luteum.
- Under the influence of LH, the corpus luteum secretes both progesterone and estrogen, but more secretion of progesterone.
- During the luteal phase, the elevated levels of estrogen, progesterone, and inhibin inhibits LH secretion and FSH secretion by acting at both the hypothalamus and anterior pituitary (negative feedback effect).
- Inhibition of FSH and LH prevents new follicular maturation and ovulation during the luteal phase.
- Low LH level causes degeneration of corpus luteum if fertilization did not occur.
- Degeneration of corpus luteum decreases progesterone and estrogen levels so FSH and LH start to rise again initiating a new cycle.

N.B.

- The plasma progesterone level increases for the first time during the luteal phase. No progesterone is secreted during the follicular phase.
- The follicular phase is dominated by estrogen and the luteal phase by progesterone.

Effect of lactation on menstrual cycles

Women who do not nurse their infants usually have their first menstrual period 6 weeks after delivery.

However, women who nurse regularly have amenorrhea (absent menstruation) for 25–30 weeks after delivery.

Nursing (suckling) stimulates prolactin secretion

- inhibits GnRH secretion and inhibits the action of GnRH on the pituitary
- inhibits LH and FSH release and antagonizes their actions on the ovaries

- inhibition of ovulation and the ovaries are inactive
- estrogen and progesterone falls to low levels
- inhibition of pregnancy

So, nursing helps birth control.

Only 5–10% of women become pregnant again during the suckling period.

Also, almost 50% of the cycles in the first 6 months after resumption of menses are anovulatory.